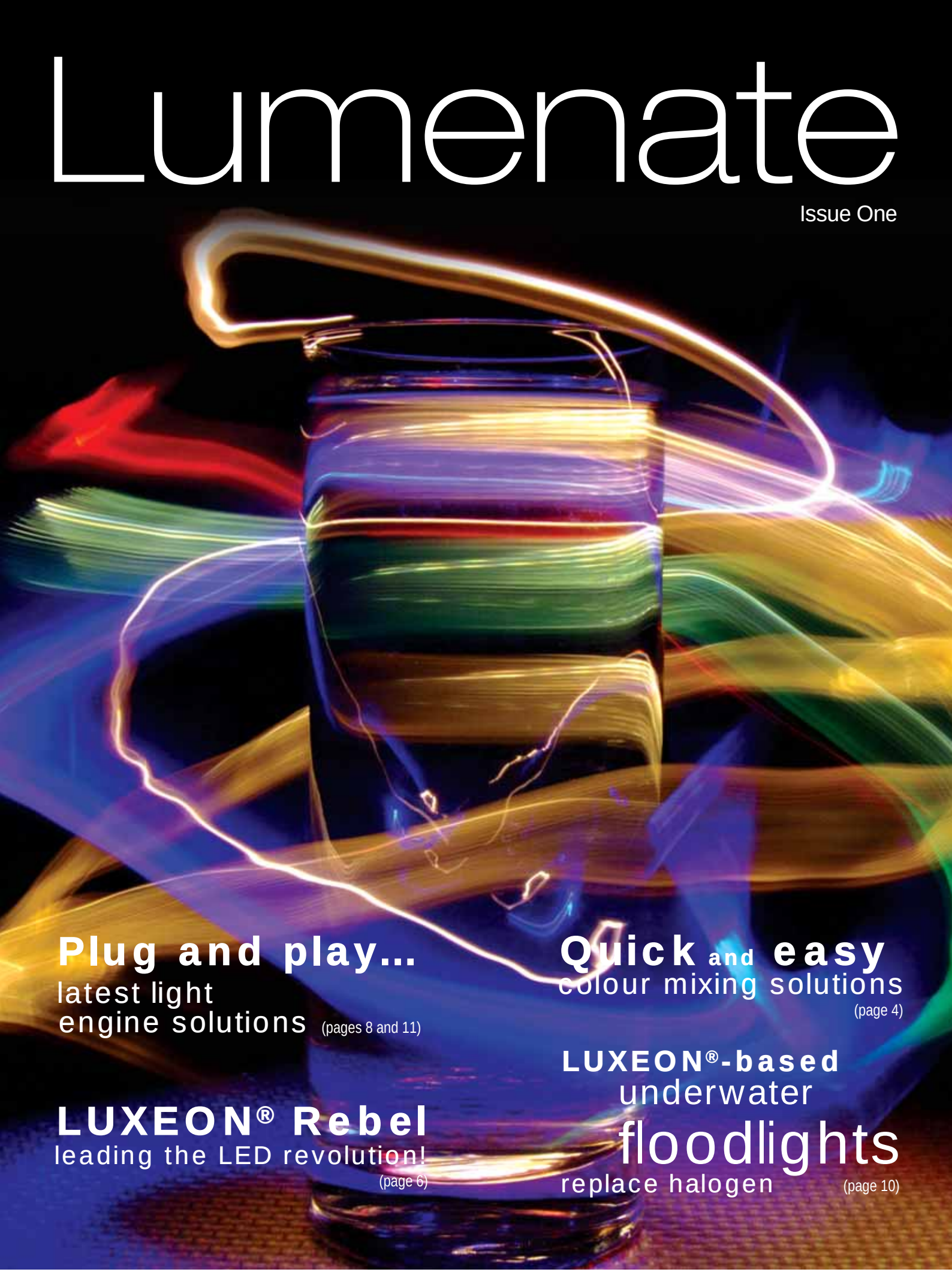
Lumenate

Issue One



Plug and play...
latest light engine solutions (pages 8 and 11)

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colour mixing solutions (page 4)

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leading the LED revolution! (page 6)

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replace halogen (page 10)

Making LED Lighting Solutions Simple™

FUTURE Lighting Solutions

Expert lighting centre offers proof-of-concept capabilities

Future Lighting Solutions runs the Lighting Resource Centre (LRC) for customers developing LUXEON® LED applications. With two dedicated LRCs, based in Montreal and Shenzen in China, as well as a Solutions Design Centre (SDC) in London, Future Lighting Solutions has a wealth of resources to enable and accelerate market adoption.

The LRCs consist of a proof-of-concept development facility and an optical-measurement lab for retrofitting and testing LUXEON-based lighting to see what can be achieved. Customers with qualified LUXEON LED lighting opportunities can use the knowledge and experience of the resident engineering team to develop products and validate their designs with high-precision laboratory equipment to minimise application development cycles. Some of the high-precision equipment on hand includes:

- **Spectroradiometers**
- **Integrating spheres**
- **Goniometers**
- **High-precision illuminance (lux) meters**
- **Circuit design and layout software tool**
- **Luminance (nit) meters**
- **LightTools® and TracePro® optical design and simulation software**

Future Lighting Solutions Certified Solutions Partners

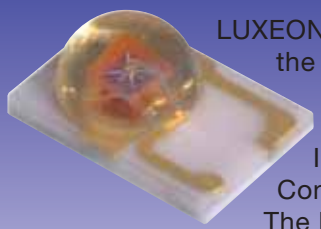
Future Lighting Solutions has witnessed the explosive growth of LUXEON high-power LEDs in all lighting markets. Our Certified Solutions Partners (CSP) network offers customers significant experience in LUXEON LED, power, thermal and optics design to facilitate and accelerate the market development and adoption of LUXEON-based solutions.

We have 52 selected partners from around Europe, Americas and Asia that demonstrate expertise, skill and understanding of LUXEON-based design from the concept stage through to production. Our Certified Solutions Partners operate in many lighting markets and bring with them expertise ranging from automotive, general lighting, architectural, entertainment, aviation and many more.

Using our CSP network offers you product design and production expertise with the minimum of investment and resources, knowing that you will have the help of an expert who is certified to enable LUXEON solutions.

Read the article on page 10 by MAL Effekt-Technik, a leading CSP in Germany

LUXEON® Rebel Scoops Prestigious Award



LUXEON Rebel has been awarded the prestigious 2007 'Technical Excellence' award at LightFair International Trade Show & Conference in New York City. The LUXEON Rebel also picked up the 'Best of Category: Speciality Lamps' award and was recognised for its high efficiency and colour quality compared to competitive devices, despite having a footprint that is only a quarter the size of other high-power LEDs.

New! Future Lighting Solutions website launched

Future Lighting Solutions has officially launched its new website. The site is dedicated to providing detailed design and engineering solutions to enable the adoption of LUXEON LEDs into mainstream applications. The site also includes the components required to complete a LUXEON-based solution, such as optics, thermal management and drivers.

www.futurelightingsolutions.com.

Welcome to Lumenate

Teresa Gibson

Dear readers, welcome to the first edition of Lumenate magazine.

Since we launched Future Lighting Solutions seven years ago, the humble LED has gone from being a simple indicator lamp to what is recognised as the next generation lighting source.

The technology has developed at an amazing rate. When Future Lighting Solutions first launched, the typical performance of a LUXEON LED was 13.9 lumens at 350mA, today we are already talking about high-power LEDs that will produce 80 lumens at 350mA and as much as 200 lumens with higher drive currents. But, as we all know, effective design is not simply about statements of Lumens per watt but more about LED reliability and the ability to truly determine the lifetime performance of LEDs under different operating conditions. Last month we saw Philips Lumileds Lighting launch a new reliability analysis tool. Finally, we can now produce a graphical representation which helps us to understand and evaluate the impact of temperature and drive current on lumen maintenance and failure rates of LEDs.

Through this analysis we can clearly see dramatic reliability performance differences between LEDs from different manufacturers allowing designers and engineers to make more fully informed decisions.

With all these great developments taking place we thought it would be valuable to produce a magazine dedicated to LED lighting solutions as a way of sharing technology breakthroughs with our customers. Lumenate will not only cover LED technology, but also the other critical elements of power, thermal and optical management which are essential to achieving the optimal usable light.

Lumenate will be published four times a year and include technical articles, product information and industry news as well as articles from our Certified Solution Partners. These will cover a wide range of segments and applications suitable for solid-state lighting.

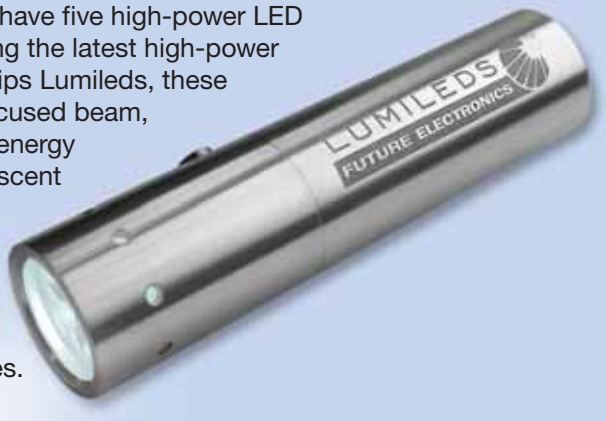
This is the first edition of Lumenate and we welcome your input and feedback. If you would like to share your comments with us please contact: **lumenate@futurelightingsolutions.com** and we will be happy to discuss your ideas.

Teresa Gibson

Managing Director
Future Lighting Solutions Europe

Win a state-of-the-art LED torch!

Future Lighting Solutions have five high-power LED torches to give away. Using the latest high-power LED technology from Philips Lumileds, these torches throw a bright, focused beam, while consuming far less energy than a traditional incandescent bulb. Respond to any of the box numbers in this issue and you will automatically be entered into the prize draw for one of the torches.



Did you know?

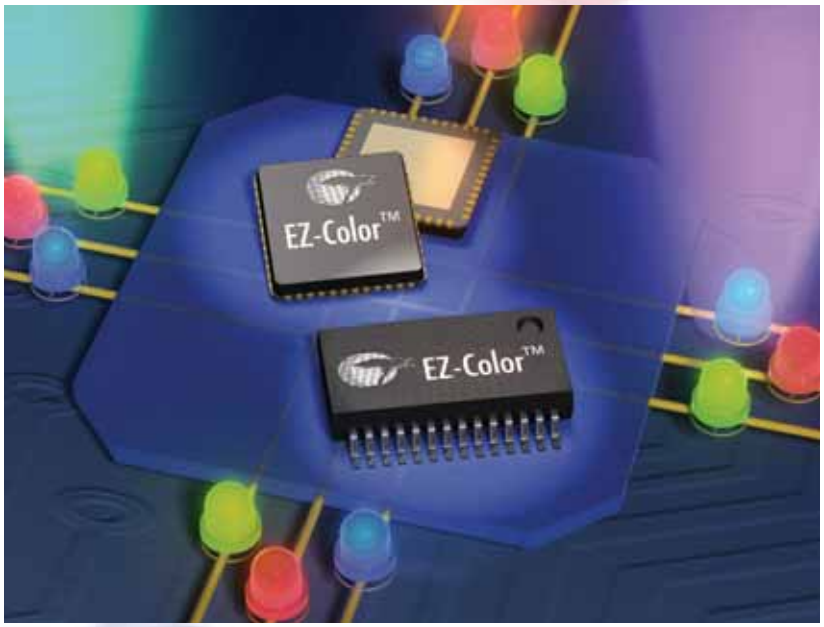
The headlamps designed into the new Audi R8 are being implemented with LUXEON LEDs.

Contents

LED controller family offers quick and easy colour mixing

Achieving consistent colour performance with LED design requires a complex set of calculations to account for a variety of factors, such as LED bin information and colour shift over temperature. The EZ-Color LED controller family from Cypress Semiconductor, supported by the PSoC Express™ embedded visual design tool, allows engineers to produce a complete design solution simply by inputting the selected LEDs and choosing a desired colour.

With PSoC Express, when designers select a colour from a range presented on-screen, pre-loaded manufacturers' specifications and temperature feedback algorithms are automatically applied to the selected design, reducing development time. The EZ-Color controller supports up to 16 independent LED channels with up to 32 bits of resolution per channel, enabling lighting designers to select LED array size and colour quality.



The EZ-Color controller family from Cypress

The controller also offers dynamic colour mixing that makes all colours within the system range accessible instead of just the pre-set colours. The dynamic colour-mixing feature also enables the system to use feedback loops to maintain the set colour output across temperature. Because a High Brightness (HB) LED's dominant wavelength, luminosity and forward voltage are all dependent on junction temperature, HB LED temperature feedback is critical for control. When the HB LED is enabled, the junction temperature increases. As a result, the wavelength increases whilst forward voltage and luminosity decrease. This produces a challenge when trying to maintain a stable colour point, since the system will be using out-dated HB LED characteristics.

The simplest method of controlling the effect of temperature on the HP LED system is through a temperature feedback loop. The temperature feedback loop will use an approximation of the HB LED's junction temperature using the board temperature, the power of the HB LED and the thermal impedance from junction to board (supplied by the HB LED manufacturer). Temperature feedback loops are simple to implement using the EZ-Color solution. EZ-Color devices can control both digital and analogue signals enabling quick use of devices such as temperature sensors (thermistors), analogue to digital converters and amplifiers. PSoC Express provides temperature compensation algorithms enabling the EZ-Color devices to maintain the correct system colour output across temperature. These algorithms update the controllers to account for current HB LED characteristics.

Dimming control or current control of the HB LED is another challenge EZ-Color devices address. Possible designs for current control can involve a PWM or expensive external ICs with external resistor control. The PWM method can dynamically change the brightness through its duty cycle for colour mixing and tends to be a more efficient solution because of its flexibility. The EZ-Color solution can support up to 16 independently-controlled HB LEDs using the PWM method.

Typical difficulties of using a PWM include high EMI and inherently low frequency flicker. Cypress has addressed these issues with PrISM™ (Precise Illumination Signal Modulation) technology, which uses a spread-spectrum dimming waveform with user-defined signal density to deliver consistent colour in varied conditions.

The CY8CLEDxx EZ-Color family includes devices that drive up to four, eight or sixteen LEDs, in applications such as architectural lighting, signage, backlighting, handset flash and torches.

Switching regulators

reduce battery count in portable lamps

Driving a power LED from a battery

Unlike a bulb, you cannot connect an LED directly to a voltage source, as this would result either in the LED not lighting up or, potentially, blowing up. You need to control the current flowing through the LED and the simplest way to do this is with a current-limiting resistor.

Generally high-power LED flash lights or torches use a 3-cell alkaline battery system. If you use a resistor drive, your battery system has to provide a voltage high enough to overcome the LED's maximum forward voltage (V_F). LEDs have a wide variation in forward voltages: the V_F of a LUXEON® high-power, white LED is typically 2.50 to 3.99V at 350mA. This value increases with the drive current and is also dependent on temperature.

In order to get a consistent level of light across your project, you have to match the limiting resistor value with the V_F of the LED, since the light output will reduce as the battery discharges and its voltage drops. Furthermore, the lamp itself will turn off when the battery voltage falls below the LED's V_F, regardless of the amount of energy available in the battery.

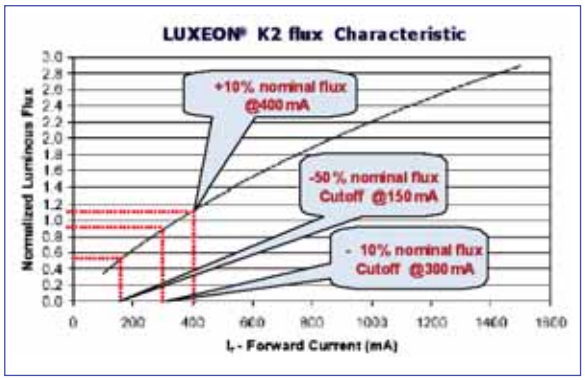


Fig. 1: Normalised luminous flux vs LED current

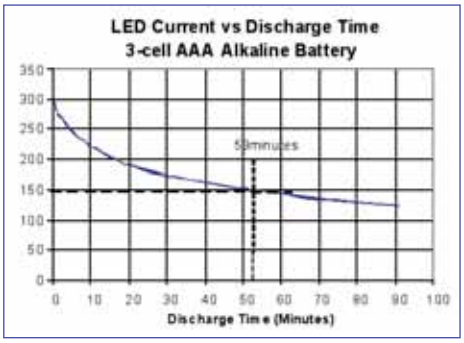


Fig. 2: LED current vs battery discharge time for a 3-cell voltage-resistor drive using a 3Ω resistor

A switching converter, however, will adjust its output voltage to the LED V_F regardless of the battery voltage. This gives you the option to keep the light output fairly constant across the battery discharge cycle or to mimic resistor-drive behaviour. The effects of variations in the LED V_F become less of an issue, as you can drain the battery completely flat before the system cuts off, or even make use of a 2-cell or 1-cell system.

Switching DC-DC converter vs voltage-resistor drive

In a resistor drive for a LXK2-PW12 LED, with a typical forward voltage of 3.4V at 350mA, operating from a 4.5V supply (3 AAA alkaline batteries), a 3Ω current-setting resistor is needed.

However, to illustrate the significance of forward-voltage variance, Figure 2 shows the LED current for this circuit driving a LXK2-PW12 LED with a forward voltage of 3.65V instead of 3.4V. The current obtained at a 4.5V supply drops from 350mA to 290mA, which represents a greater than 10% light-flux reduction as shown in Figure 1. This illustrates that resistor tuning is required for LEDs with varying forward voltages.

Low-cost, constant-current DC-DC converters help to solve issues related to LED drive, battery life and overall size and weight. Typical ZXSC400 and ZXSC310 boost converter circuits for a 2-cell battery system are available via email from lumenate@futurelightingsolutions.com. The ZXSC400 operates from voltages down to 1.8V while the ZXSC310 operates down to 0.8V as shown in Figure 3.

When analysing battery voltage against discharge time for a 2-cell alkaline circuit using a ZXSC400 to drive a LED at a nominal 350mA, the time for the battery voltage to drop to 2V is approximately 22 minutes. This is the point where forward current drops to 300mA, giving a 10% reduction in luminous flux. In the same test, using a ZXSC310, the time for the battery voltage to drop to 2V is approximately 56 minutes. This gives a forward current of 150mA, resulting in a 50% reduction in luminous flux.

Conclusion

A 2-cell AAA battery with a ZXSC400 constant-current boost converter gives longer operational times at higher flux output as well as more constant luminous flux than a 3-cell AAA battery using a resistor drive. For a 50% luminous flux cut-off point, a 2-cell AAA battery ZXSC310 system gives a similar run time to a 3-cell AAA battery with a resistor drive.

Therefore, the use of a switch-mode boost converter improves energy utilisation, battery life and is generally a 'greener' solution than that offered by resistor drives.

With the switching regulator, the variation in forward voltage of the LED is no longer an issue and use of a 2-cell instead of a 3-cell system offers significant reduction in overall size and weight.

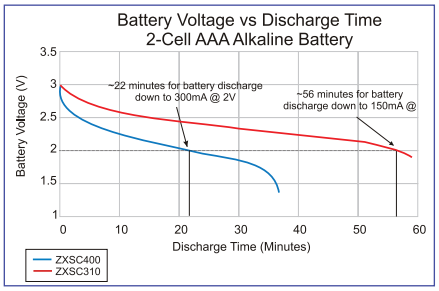


Fig. 3: Battery voltage vs discharge time for 2-cell AAA alkaline battery

TWO FREE BOARDS TO BE WON!

Future Lighting Solutions and Zetex Semiconductors are offering two ZXSC400EV3 development kits. If you would like to enter the prize draw please email your name and contact details to: lumenate@futurelightingsolutions.com

FUTURE Lighting Solutions
Making LED Lighting Solutions Simple™

When responding to this article please quote the reply number 02

Email: lumenate@futurelightingsolutions.com

Can a rebel start a revolution?

Ultra-compact, high power, and with industry-leading flux density. The LUXEON® Rebel boasts an impressive specification, but what does that mean to the designer?

Lighting designers will always want to get the most from light sources. For high-power LEDs that means delivering more light from a smaller package.

The first and most obvious advantage the LUXEON Rebel offers on this front, is a footprint of just 3mm x 4.5mm. Combined with industry-leading luminous flux, these dimensions free designers to create brighter LED arrays and slimmer end-products, but is there a catch?

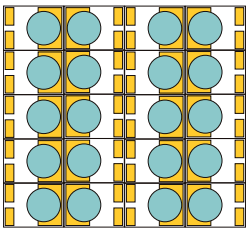
Taking the heat

The result of pushing light-output and board-space boundaries is the inevitable accumulation of thermal energy. Philips Lumileds have addressed this in two ways: the LUXEON Rebel operates with a maximum junction temperature of 150°C and features an electrically-isolated thermal pad.

This allows pads to be mounted on a single heat-sink without additional isolation or the use of an FR4 board with thermal vias. As well as aiding thermal management, the design of the LUXEON Rebel thermal pad and contact also has implications for LED layout.

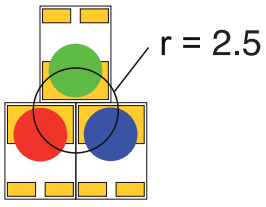
Design strategies

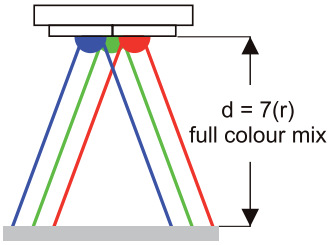
An extremely small footprint gives the LUXEON Rebel versatility, particularly with applications requiring densely-packed LED arrays. Also, because the thermal pad is over 1.8mm from the electrical connections, thermal creepage is kept to a minimum. This allows the LUXEON Rebel to work with high voltage differences, a critical requirement for driving neatly arranged serial strings of LEDs.



20 LUXEON® Rebel = 316.5mm²
75lm/LED = 1500 lumens @ 350mA

Another application requiring multiple LEDs mounted in close proximity is RGB mixing. The LUXEON Rebel layout has a direct affect on the way in which designers can achieve colour mixing. As well as allowing a greater number of LEDs on a single board or under a single optic, being placed in close proximity means that LUXEON Rebel devices can automatically achieve a high level of colour mixing at reduced distances of around 15mm. This opens new design possibilities for power LEDs in areas such as colour bricks, interior lighting and video walls.





Defining the colours

With the LUXEON Rebel designers are offered a broad palette of colours and shades of white to work with. The LUXEON Rebel White LED is available with CCTs from 2,670K to 10,000K. These options are split into three industry-optimised categories with typical CCTs of 3,000K, 4,100K and 6,500K.

Philips Lumileds' patented conformal coating ensures low CCT variance over angle. Future Lighting Solutions supports a comprehensive binning structure which is detailed in the LUXEON Rebel datasheet.

	Bin	Warm White 3000K	Neutral White 4100K	Cool White 6500K	Bin	Royal Blue 455nm	Blue 470nm	Bin	Green 530nm	Cyan 505nm	Red 627nm	Red-Orange 617nm	Amber 590nm
MINIMUM LUMENS AT SPECIFIED TEST CURRENT													
350mA	G	40	40	40	A	175mW	8.2	E					23.5
	H	50	50	50	B	225mW	10.7	F		30	30		30
	J	60			C	275mW	13.9	G	40	40	40	40	
	K		70	70	D		18.1	H	50			50	
	L		80	80	E		23.5	J		60			
								K	70	70			
								L	80				
TYPICAL LUMENS AT SPECIFIED OPERATING CURRENT													
700mA	G	80	80	80	A		19	E					50
	H	95	95	95	B		22	F		65	65		65
	J	110			C		27	G	80	80	85	85	
	K		130	130	D		38	H	95			100	
	L		145	145	E		48	J					
								K	130				
								L	145				

Reliability meets clarity

High-power LEDs are the work-horses of solid-state lighting. Much is asked of their reliability. So before designing in a particular LED, you need to know your production run will not be restricted by sub-standard testing. That is why we've taken a closer look at what Philips Lumileds put the LUXEON Rebel through before it crosses your production line.

To start with, every LUXEON Rebel is tested and binned in-house. All colour dies are produced, assembled, tested, binned, and quality controlled by Philips Lumileds, ensuring that any particular batch of LEDs maintains an equal standard.

The LUXEON Rebel in particular achieves the lowest possible rating for moisture sensitivity (JEDEC Level-1) meaning that manufacturers benefit from indefinite shelf life, with no dry pack, sealing, or baking to worry about. LUXEON Rebel is compatible with JEDEC 020c, lead-free reflow, and can handle up to three re-flow cycles for complex assembly procedures or board reworks.

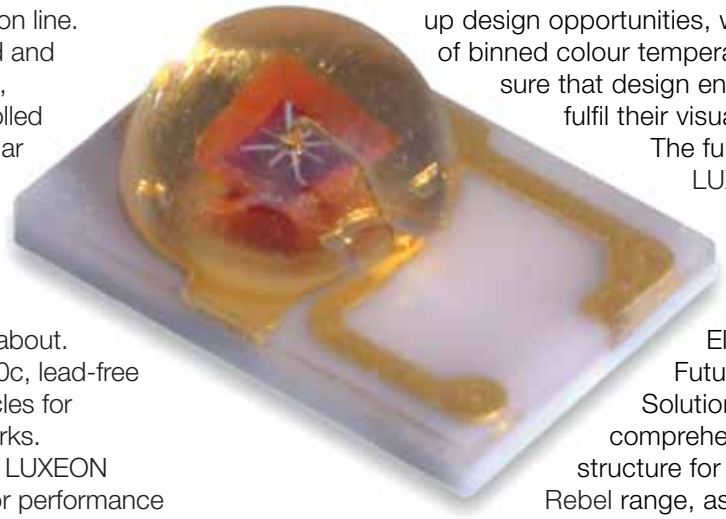
As well as offering high maximum stats, the LUXEON Rebel is binned with guaranteed minimums for performance so that designers can avoid nasty surprises. The way in which Philips Lumileds produces lifetime and lumen maintenance data also sets them apart. Unlike some manufacturers, when Philips Lumileds claim a thousand hours testing they literally mean a thousand hours - not a hundred hours for ten products or one single gruelling hour for a 1,000 products.

Projections of recorded data show that the LUXEON InGaN products deliver, on average, 70% lumen maintenance at 50,000 hours of operation at a forward current of 700mA. This projection is based on constant current operation with junction temperature maintained at or below 135°C.

Unlike many LED manufacturers, Philips Lumileds publish an application note that details their reliability data. To request this email: **lumenate@futurelightingsolutions.com**

Did you know?

LUXEON Rebel won the 'Technical Excellence' award at the 2007 Lightfair International Tradeshow & Conference.



Does the LUXEON Rebel have a cause?

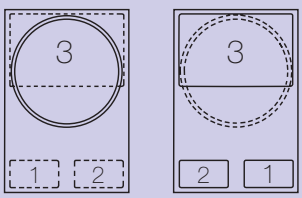
The combination of thermal performance, reduced dimensions and high light output means that the LUXEON Rebel can genuinely open up design opportunities, whilst the range of binned colour temperatures makes sure that design engineers can fulfil their visual requirements.

The full range of LUXEON Rebel high-power LEDs are supported by Future Electronics. Future Lighting Solutions offers a comprehensive support structure for the LUXEON Rebel range, as well as holding a ready-to-ship inventory for all the available colours.

For more information email: **lumenate@futurelightingsolutions.com**

Product Snapshot

- **Dimensions:** 3x4.5x2mm
- **Max junction temp:** 150°C
- **Max drive current:** 1000mA
- **Lumen maintenance:** 70% @ 50k hrs @ 700mA (InGaN)
- **Range:** Selection of colour options; AlInGaP and InGaN technologies



AVAGO TECHNOLOGIES

Mid-power LEDs
higher drive currents

Designed as an extension to the current PLCC-4 series, Avago's 0.5W mid-power LEDs utilise improved package design and heat dissipation to operate at higher drive currents. Critically, this results in improved light output and flux performance compared with PLCC-4 surface-mount LEDs available from other manufacturers.

The new ASMT-Q series devices exhibit high light output and reliability under a range of environmental conditions, including exterior automotive lighting, indoor and outdoor electronic signage, and industrial control panels. Enhanced resin materials are used to extend operating lifetime and minimise degradation. Whatever the application, Future Lighting Solutions can support this LED series. For more information visit **www.avagotech.com/products** or contact your local Future Electronics office.

FEATURES

- 3.2mm x 2.8mm x 1.9mm PLCC-4 platform
- Typical luminous flux:
  White (InGaN) 17lm @ 150mA
  Amber (AlInGap) 11.4lm @ 150mA
  Red-Orange (AlInGap) 14lm @ 150mA
  Red (AlInGap) 9.8lm @ 150mA
- Warm White, Blue and Green colours will be market released in the coming months
- Robust operating temperature -40°C to 100°C
- Compatible for both IR and TTW soldering process
- 120° viewing angle

APPLICATIONS

- Automotive
- Backlighting
- Dome/map lighting
- Puddle lamp/glove compartment illumination
- Decorative lighting
- Signage

RGB light source blends
thermal management with performance

Avago's high-power LED Plug and Play modules are high performance, extraordinarily user-friendly, high-brightness light sources that give a new dimension to the packaging of LED light source. Its slim and compact footprint makes it easy for horizontal and vertical stacking. Assembly of the light source is extremely simple with the plug and play mechanical mounting and electrical connector, reducing the need of assembly machine investment and tight process control that is inevitable for conventional LED packages.

TWO FREE BOARDS TO BE WON

Future Lighting Solutions and its Solutions Partners have co-developed a board to demonstrate the advantages of the JukGaRak solution and highlight its programming flexibilities. If you would like to enter the prize draw please email your name and contact details to: lumenate@futurelightingsolutions.com

The JukGaRak features a built-in heat sink and mechanical mounting designed to simplify thermal management, enabling effective heat transfer and maintaining LED junction temperature. The reflector cavity has been designed to maximise light extraction as well as colour mixing. Integrating 20 Red, 20 Green and 10 Blue closely-pitched 0.5W LED dice on a 10cm Metal Core PCB, the colour mixing is best in its class.

Two versions of the JukGaRak are currently available: The top-emitting version (ADJD-MJ51) measures 100mm x 18mm x 3.6mm with an aperture of 96mm x 6mm; the side-emitting version (ADJD-MJ61) measures 100mm X 18mm X 8mm with an aperture of 96mm x 4.6mm. The JukGaRak can be used with the PSoC driver detailed on page 4. The RGB drive capabilities of Avago's 24W light source make this an ideal fit for many lighting applications.

For ease-of-use the ADJD-MJ51 and ADJD-MJ61 include a connector cable.

- Decorative lighting
- Architectural lighting
- Speciality lighting
- Full-colour backlighting
- Colour washing
- Plug and play connection and mount
- Fully serviceable due to ease of mounting and de-mounting
- Integrated heatsink to simplify thermal management
- Red, Green and Blue colour premix in the reflector cavity
- Silicone encapsulation for long product life:
  no degradation after 10,000hrs @ max. current and T_a 70°C
- High typical flux output: Red 200lm @ 300mA; Green 250lm @ 300mA; Blue 30lm @ 150mA; RGB 480lm @750mA

Efficient LED-ballast design with power regulators

ON Semiconductor

With the proliferation of high-luminosity LEDs, the lighting industry is now moving towards compact Switch Mode Power Supplies (SMPS) to provide efficiency. ON Semiconductor power regulators offer a simple and economical way to design power supplies that comply with stringent energy-saving requirements. The proprietary high-voltage technology includes a 700V power MOSFET with a start-up current source, all directly connected to a bulk capacitor.

As an example, they've designed an isolated, universal-input LED ballast, operating with LUXEON LEDs and providing a wide input-voltage range from 85VAC to 265VAC. The NCP1013 low-cost, monolithic controller minimises peripheral circuitry by integrating functions such as start-up and current limit. A patented Dynamic Self-Supply (DSS) function, for example, eliminates the need for a transformer auxiliary winding by allowing the integrated circuit to bias itself directly from a high-voltage input rail.

The board includes an input filter, a bridge rectifier, smoothing capacitors, a power stage and a rectifier diode, as well as bulk capacitors and line inductor in a Pi-filter arrangement. There is a constant current drive feedback topology for the LEDs with a constant voltage in the event of an open circuit output.

The circuit delivers 5W of output power and can drive one or two LEDs. The output current can be adjusted to 350mA, 750mA or 1,000mA to match with the requirements of the LUXEON LED range. More information on low-cost 1N4007 diodes and NCP1013 monolithic controllers is available from Future Lighting Solutions.

Secondary optics harness the LUXEON Rebel

carclo technical plastics

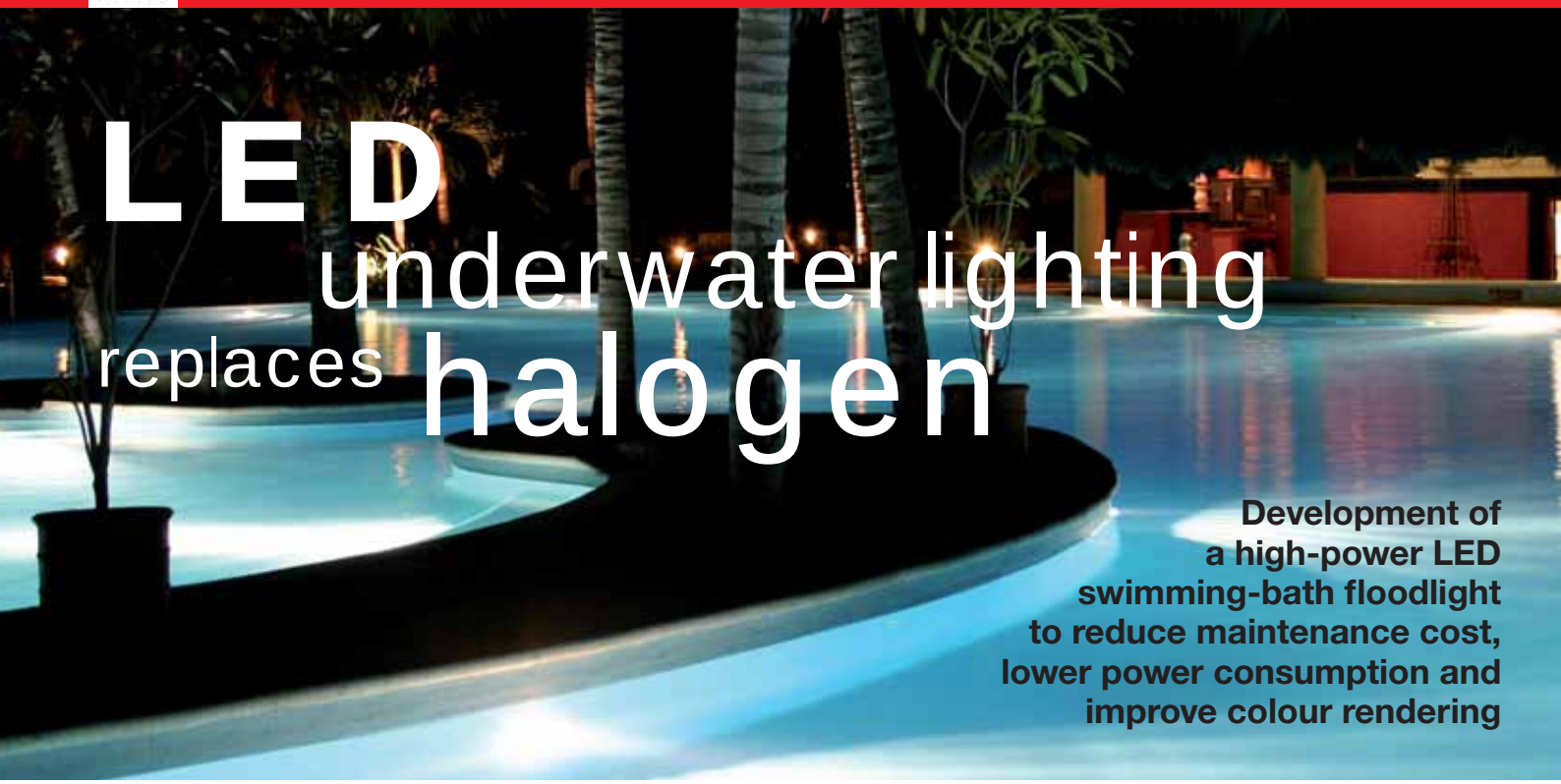
To quote Pirelli's tyre advertisment, 'Power is nothing without control'. Equally, the same analogy can be drawn with lighting: the end user is unlikely to care how many lumens of light their luminaire radiates, compared to visible lux or candela in the area of illumination. Producing the required values of lux means controlling and directing light output and, in the same way, it means keeping light away from other areas.

To help designers make the most of their LUXEON Rebel LEDs, Carclo has developed a range of optimised 20mm-diameter secondary optics. These include optics capable of producing beam widths between 9° and 35° Full Width Half Maximum (FWHM), as well as an optic capable of producing an elliptical beam measuring 10° by 40°, and two frosted variants with integrated diffusers suitable for architectural applications.

All of these optics boast upwards of 85% efficiency, allowing users to make the most of the LUXEON Rebel LEDs. When mounting secondary optics it should be remembered that positioning optics at the correct height relative to the LED is critical to achieving the best efficiency and the correct beam width.

The alignment of the optic axis to the LED chip also plays a part. If incorrectly positioned, the output beam will become uneven and offset. The placement accuracy required is dependent on the beam width of the optic. Generally the wider the beam divergence of the optic the more tolerant it will be of axial displacement. As a general guide, an accuracy of ±0.25mm is required for optics that produce the narrowest beams.

To help users mount their optics at the correct focus height and to align them with the LUXEON Rebel LED chip, Carclo can supply a general-purpose optic holder that mounts on the PCB and locates the optics correctly above the LUXEON Rebel. Further details of Carclo's optics and holders are available from Future Lighting Solutions.



LED underwater lighting replaces halogen

Development of a high-power LED swimming-bath floodlight to reduce maintenance cost, lower power consumption and improve colour rendering

In 2004 MAL Effekt-Technik undertook the challenge of creating a high-power LED swimming-bath floodlight to replace existing halogen lighting. The aim was to create a module fitting the standard mounting of a 150W halogen-based underwater floodlight with comparable or improved quality illumination.

They began by sizing up the competition, and analysing relevant data for the halogen model. For instance, the halogen floodlight was measured with an optical measuring bench to register the whole lighting allocation which would need to be reproduced. Additionally, the halogen reflector was optically measured and included in the data used to develop the secondary optic for the high-power LED module.

The first major challenge was to specify the electronic requirements. Since there was only a two-core wire leading to the floodlight, electronic control had to be placed within the high-power LED module itself. The maximum voltage was limited to 24V, so MAL Effekt-Technik decided to use an external switching power supply with Power Factor Correction, featuring an input voltage range from 100V to 300V and an output voltage of 24V.

Based on the analysed optical data MAL Effekt-Technik calculated that the required amount of lumen output equated to 24 LUXEON III LEDs. Ideally, MAL Effekt-Technik would have preferred to use more LEDs but, as this was a retro-fit assignment, space was limited. Using LUXEON III Stars various prototypes were built and tested, which MAL Effekt-Technik used to develop the secondary optic and to test the electronic control equipment.

After final mechanical configuration of the LEDs, the PCB was developed. MAL Effekt-Technik opted for Metal Core Printed Circuit Board (MCPCB) material by Bergquist as this offered the heat conductance required to efficiently drive the high-power LEDs.

As MAL Effekt-Technik strongly believe in the importance of efficient and intelligent thermal management, an 8-bit microcontroller was integrated into the high-power LED module to control temperature, supply constant current via a switching regulator step and to implement soft-start. Both the microcontroller and the switching regulator were to be included on the PCB, which added to the demand on the limited amount of available board space.

The biggest issue, however, was how to remove heat from high-power LEDs housed in a stainless steel floodlight case. Stainless steel has a bad heat conductance value, so MAL Effekt-Technik designed an aluminium heat-sink which stored enough heat to allow dissipation through the stainless steel case and into the surrounding water. To achieve this, various calculations, simulations and prototypes were required. MAL Effekt-Technik eventually achieved a slug temperature of 45°C at a water temperature of 30°C.

Since the completion of the project MAL Effekt-Technik have built and sold hundreds of the underwater floodlights – single colours as well as RGB. Also, their adoption of high-power LED technology has not stopped and today MAL Effekt-Technik produce underwater floodlights with 27 LUXEON K2 LEDs and an input voltage of 12V. For the second half of 2007 MAL Effekt-Technik plans to release a module with 36 of the latest LUXEON Rebel LEDs. These continuing developments are reducing maintenance cost, lowering power consumption and improving colour capabilities for swimming-bath lighting.

Markus Vockenroth
Managing Director – MAL Effekt-Technik

Did you know?

There are currently 24 certified solutions partners across Europe...

...and it's growing still!

Modular RGB light engines

LinkLED™ RGB light engines enable OEMs to easily construct full colour-change applications using LED technology. With simple plug and socket connections, they can be used for a wide range of applications, including architectural detail lighting and signage. These modules are supplied ready to use, complete with plug and socket connections, and thermal adhesive for direct assembly on metal surfaces.

The Dialight drivers range

Dialight Lumidrives has developed a range of drivers optimised for LUXEON LEDs. COLOURDRIVER™ includes complete dimming implemented with an on-board DMX512 interface and PWM power control. A thermal feedback circuit monitors LED temperature, ensuring maximum reliability and protection. COLOURDRIVER is available in a range of options from stand-alone remote ballasts to IP65 enclosed and OEM modules for integration within light fixtures.

LumiSpot light engines

Dialight Lumidrives produce a range of light engines from circular to linear modules. The LumiSpot range offers four circular LED arrays designed to complement the Lumidrives Microdrivers and are ideal for a variety of OEM solutions.

LumiSpots come in six different single-colour LEDs and four different beam angles. Complete with optics, the range offers the ability to create LED-based lighting systems with an incredibly quick time to market by utilising off-the-shelf Plug and Play modules. They can be driven either singly or in multiples (depending on the total number of LEDs and the driver used), giving an increased level of flexibility in lighting design.

The optics and optic holders used are from the new F-Form range, exclusive to Lumidrives and supported by Future Lighting Solutions.

Dialight Lumidrives

Product Directory

Manufacturer	LED								Optic					Thermal			Driver				
	Low Power				High Power																
	Lamps/Displays	< 200mW	> 200mW	0.5 watt	1 watt	3 watt	5 watt	Light Engine	Narrow	Medium	Wide	Elliptical	Custom/Other	Standard	Custom	Active	Low Voltage	Medium	High	Control Modules	
Aavid Thermaloy														•	•						Thermal tape available
Advance																			•		Xitanium driver
Avago	•	•	•	•	•	•		•													
Carclo									•	•	•	•	•								TIR lenses
CML	•	•																			
Cypress																	•	•	•	•	PSoC programmable driver
Dialight Lumidrives	•	•	•					•	•	•	•	•	•				•	•	•		
Fraen									•	•	•	•									TIR lenses
Freescale																	•				Programmable modules (PWM)
I2 Systems																	•	•			Wire harness available (VCA-87)
IMS									•	•	•	•									Reflectors
Kingbright	•	•	•																		
LED Dynamics																	•	•			BuckPuck, wire harness available (3021HEP)
Lumex	•	•	•										•								
Melexis																		•			ISO/TS16949 Automotive compliant
Microchip																				•	
National																		•			
NXP																	•	•	•	•	
On Semi																	•	•	•		
Philips Lumileds					•	•	•		•												Lines, rings, arrays.
Polymer									•	•	•	•	•								TIR lenses
Rohm	•	•																			
Sipex																	•	•			
STMicroelectronics																	•	•	•		
Sunon																•					Fans, blowers
Vishay	•	•	•																		
Zetex																	•	•			

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